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ENROLLMENTS AND DEGREES

As we confront the last decade of the century, there is a tendency to look back and evaluate past trends for the purpose of making recommendations on how to achieve future goals. Science education is among the current societal issues; our concerns focus on matching the production of physicists to their utilization in the United States. To implement meaningful guidelines one requires a reliable data base. For the past thirty years physics students all over the U.S. have been carefully monitored by means of an annual survey. This survey of Enrollments and Degrees keeps track of physics students whose interest in physics ranges from enrolling in a non-mathematical introductory course, merely as an elective, to completing a doctoral dissertation in one of the physics subfields.

All the information presented in this report was collected from physics and astronomy departments classified according to their highest physics or astronomy degree programs. The 1991 survey requested the enrollments for 1991-92 and the degrees conferred in 1990-91. To be able to evaluate changes, we present seven tables showing trends of physics or astronomy data.

Each year, interchanges take place among the three types of institutions whereby existing degree programs may either be expanded to include a higher degree, or the currently-offered degree program may be discontinued if too few students express an interest in it. **Table I** reflects those changes in the number of institutions over the past five years and identifies five institutions, in a footnote, that have two physics doctorate-granting departments; in each case, the second one grants an applied-physics doctorate.

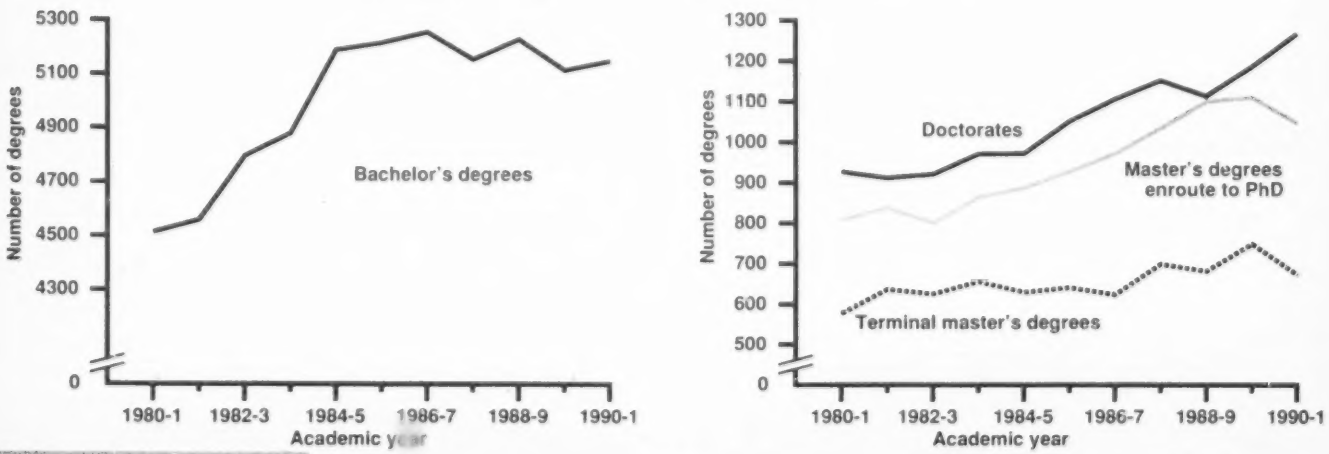
Table I. Institutions by highest physics degree offered, 1987 to 1992.

Academic year	Doctoral-granting*	Master's-granting	Bachelor's-granting
1987–88	169	90	498
1988–89	169	89	496
1989–90	171	86	496
1990–91	172	84	491
1991–92	173	83	491

**Five of these institutions have two physics doctorate-granting departments. They are Stanford U., U. of CA-Davis, Yale U., Harvard U. and Cornell U.*

The four types of physics degrees granted each year are presented as ten-year trends in **Figure I**. By making a distinction between a terminal master's degree and one granted enroute to a higher physics degree, we are presenting four trends for three levels of physics degrees. The bachelor's degrees continued their leveling trend as the anticipated increase in doctorate production (7%) turned out to be greater than projected. Both types of master's degrees showed declines but for different reasons. The 10% drop in terminal master's degrees is probably linked to the recent increases in part-time graduate students. The decline in "master's enroute" may be attributable to an increase in students who entered doctoral programs that do not call for that intermediate degree.

Figure I. Physics degrees awarded by academic year, 1980 to 1991.



Member Societies: The American Physical Society • Optical Society of America • Acoustical Society of America • The Society of Rheology • American Association of Physics Teachers American Crystallographic Association • American Astronomical Society • American Association of Physicists in Medicine • American Vacuum Society • American Geophysical Union

Table II. Physics enrollments and degrees awarded by academic year, 1980 to 1992.

Academic year	Number of physics degrees granted (July 1 to June 30)			Undergraduate physics major enrollments		Graduate physics student enrollments	
	Bachelor's	Master's	Doctor's	Juniors	Seniors	Total	1st year
1980–81	4513	1387	927	5905	5091	9 934	2564
1981–82	4558	1476	912	6386	5372	10 173	2637
1982–83	4795	1426	921	6299	5580	10 429	2630
1983–84	4878	1521	971	6303	5658	10 922	2855
1984–85	5188	1518	972	6601	6009	11 337	2863
1985–86	5214	1589	1051	6689	6092	12 011	2981
1986–87	5253	1596	1105	6592	6119	12 616	3162
1987–88	5152	1733	1150	6412	5959	13 143	3274
1988–89	5226	1781	1112	6390	5914	13 361	3132
1989–90	5111	1857	1183	6313	5896	13 708	3059
1990–91	5145	1718	1264	6445	6031	14 065	3278
1991–92				6435	6126	14 534	3306

**Include part-time students.*

For **Table II** we combine the two types of master's degrees when we present the numerical data for **Figure I** and add the undergraduate and graduate enrollments for the entire decade of the 1980s. Noteworthy among these data are the increases in both total and first-year graduate students.

Following the categories used in **Table I**, we examined the enrollment and degree trends for each of the three types of institutions and thereby created **Table III**. The format of this table shows that 173 doctoral institutions enroll approximately half of the undergraduate physics majors, thereby spreading the other half among 573 physics departments. The graduate enrollment at master's institutions continues to comprise approximately 10% of the total.

Table III. Undergraduate and graduate enrollments and degrees by institution type, 1980 to 1992.

Academic year	Number of physics degrees granted (July 1 to June 30)			Undergraduate physics-major enrollments		Graduate physics student enrollments	
	Bachelor's	Master's	Doctor's	Juniors	Seniors	Total	1st year
Doctoral-granting institutions							
1980–81	2123	1161	927	2765	2568	9 062	2223
1981–82	2179	1281	912	2996	2671	9 273	2275
1982–83	2192	1210	921	2962	2645	9 524	2288
1983–84	2195	1319	971	2955	2824	10 006	2495
1984–85	2460	1286	972	3059	3105	10 357	2443
1985–86	2377	1358	1051	3120	2961	10 937	2574
1986–87	2473	1357	1105	3132	3148	11 389	2667
1987–88	2460	1432	1150	3030	2991	11 880	2737
1988–89	2526	1465	1112	3018	2972	12 069	2638
1989–90	2463	1490	1183	2877	2993	12 440	2623
1990–91	2462	1414	1264	3082	3077	12 700	2782
1991–92				3057	3096	13 118	2831
Master's-granting institutions							
1980–81	589	226		868	655	872	341
1981–82	532	195		917	734	900	362
1982–83	554	216		877	752	905	342
1983–84	610	202		830	722	916	360
1984–85	658	232		974	781	980	420
1985–86	632	231		1014	865	1 074	407
1986–87	660	239		913	791	1 227	495
1987–88	591	301		871	750	1 263	537
1988–89	582	316		822	795	1 292	494
1989–90	517	367		773	737	1 268	436
1990–91	569	304		800	760	1 365	496
1991–92				802	765	1 416	475
Bachelor's-granting institutions							
1980–81	1801			2272	1868		
1981–82	1847			2473	1967		
1982–83	2049			2460	2183		
1983–84	2073			2518	2112		
1984–85	2070			2568	2123		
1985–86	2205			2555	2266		
1986–87	2120			2547	2180		
1987–88	2101			2511	2218		
1988–89	2118			2550	2147		
1989–90	2131			2663	2166		
1990–91	2114			2563	2199		
1991–92				2576	2265		

**Include part-time students.*

Table IV. Number of students enrolling in their first college/university physics course in 1991–92.

Type of course	Type of physics department: Doctoral-granting Calculus-based	Doctoral-granting Algebra-based	Doctoral-granting Non-math.	Nondoctoral-granting Calculus-based	Nondoctoral-granting Algebra-based	Nondoctoral-granting Non-math.	Total Calculus-based	Total Algebra-based	Total Non-math.
Discipline of potential majors							(thousands)		
Engineering majors	66%	3%	2%	53%	6%	1%	93.0	5.6	1.2
Physical sciences majors*	17	7	3	27	9	1	30.3	9.3	1.4
Biology, health-related majors	12	54	5	9	56	5	16.4	65.9	3.4
Other, incl. not yet declared	5	36	90	11	29	93	10.3	39.2	69.0
	100%	100%	100%	100%	100%	100%			
Numbers in thousands	97	67	36	53	53	39	150.0	120.0	75.0
Total introductory enrollment	200,000			145,000			345,000		
Number of physics departments	172 departments**			573 departments			745 departments		

Includes physics, chemistry, mathematics, etc.

***There are six doctoral-granting institutions that have no undergraduate physics program.*

Introductory physics enrollment

An important part of creating a better educated work force is to increase the distribution requirements for freshmen irrespective of their majors. The physics departments are responding to these challenges by offering a diversity of introductory physics courses. All the enrollments reported for 1991-92 reflected small increases over those of the previous year, which can be interpreted as an encouraging sign. **Table IV** relates the enrollments of broad categories of potential majors to three levels of introductory physics courses. It should be mentioned that only a small proportion of the 345,000 students will have chosen the introductory physics course as an elective. We present three total columns in **Table IV** thereby showing that engineering majors, who took a calculus-based course, comprised the largest proportion (27%) of the total enrollment; they are followed by the non-science majors (20%) to whom the non-mathematical courses generally appealed. Few biology or health-related majors take calculus, which in turn obliges them to enroll in the algebra-based courses. The last two rows of **Table IV** are a further illustration of the uneven distribution of students because one can calculate that 23% of the physics departments enroll 58% of the introductory students.

Undergraduate physics majors

Although a majority of institutions does not require undergraduates to declare a major until they reach their junior year, the number of required courses for physics majors is so great that it is desirable to make that decision as close to the freshman year as possible. Consequently, chairpersons who monitor the enrollments in lower level physics courses can provide estimates of how many prospective physics majors there are among the freshmen and sophomores. For over a decade those collective estimates ranged from eight to nine thousand freshmen and were based on the enrollments in courses that constitute prerequisites for higher level physics courses. However, many of the estimates can be considered optimistic because they were linked to an attrition of 18% between the freshman and sophomore classes. For the entire four-year period, only two-thirds of recent classes of freshman physics majors sustained their interest in the subject matter.

In **Figure II** we trace the collective attrition of the class of 1992 and illustrate by means of actual as well as projected data the kind of attrition we expect for the classes of 1993 through 1995. Past studies have shown that smaller

Figure II. Actual and projected number of undergraduate physics majors.

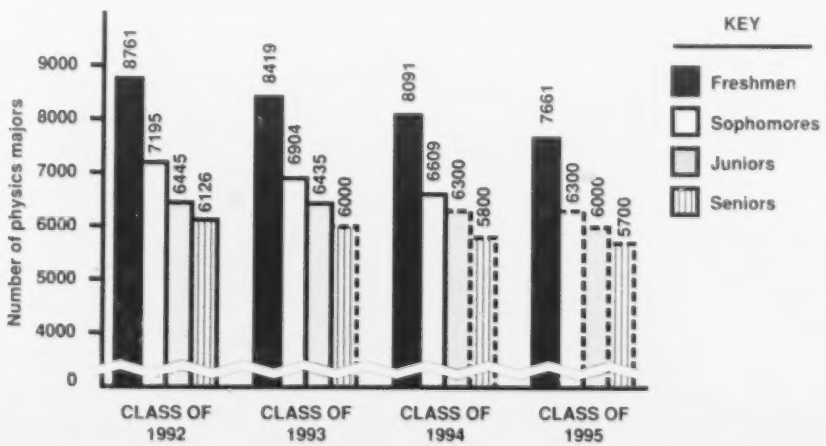


Table V. Attrition of undergraduate physics majors by type of institution, 1978–79 to 1990–91.

Graduating class	Doctoral-granting institution		Master's-granting institution		Bachelor's-granting institution	
	No. of juniors	% Completing bachelor's degree	No. of juniors	% Completing bachelor's degree	No. of juniors	% Completing bachelor's degree
1980	2830	76%	780	74%	2180	80%
1985	2990	78	895	71	2515	84
1989	3060	81	870	65	2535	84
1990	2980	82	820	67	2540	83
1991	2990	81	800	67	2560	81

Note: Number of juniors and bachelor's degrees are based on 3-year averages.

numbers of freshmen tend to include a greater proportion of serious students. Hence we project the attrition rates to decline from 30% to 26% by 1995.

In spite of the diversity of programs, the prevailing requirement is for undergraduates to declare their majors by the beginning of the junior year. Thus, the attrition rate that causes concern is the one that occurs between the beginning of the junior year and the completion of the bachelor's degree. To show what differences exist in attrition rates among the three types of institutions, we present **Table V**. In terms of class size, the distribution of juniors has been remarkably stable, since 1989, at the doctorate and bachelor's-granting institutions; and their retention rates were above 80%. At master's-granting institutions, junior classes appear to decline and only two-thirds of the juniors complete their bachelor's degrees. To put these retention rates into perspective, **Table V** includes the graduating classes of 1980 and 1985. The comparison over a twelve-year period highlights an improved retention at the PhD-granting institutions, a declining retention at the master's institutions, and no significant changes at the four-year colleges.

It should be noted that undergraduate physics programs are offered in all regions of the United States as indicated by the distribution of physics majors in **Table VI**. The last column of data, labeled "Fifth-year undergraduates" primarily includes employment-oriented students who changed to a part-time status in order to acquire some experience with the job market before completing their bachelor's degrees. The size of this group has doubled since the early 1980s.

Table VI. Undergraduate physics majors by geographic region and type of institution, 1991–92.

Geographic region*	Estimated** no. of freshmen	Estimated** no. of sophomores	Number of juniors	Number of seniors	Fifth-year undergraduates
New England	548	642	546	491	52
Mid Atlantic	1245	1055	1030	902	145
E. N. Central	1325	1059	964	959	161
W. N. Central	717	604	561	525	104
S. Atlantic	1214	1045	972	820	97
E. S. Central	387	340	305	256	41
W. S. Central	811	630	574	533	75
Mountain	516	459	466	606	163
Pacific	898	775	1017	1034	300
Total	7661	6609	6435	6126	1138
Doctoral-granting inst.	3024	2822	3057	3096	633
Master's-granting inst.	956	837	802	765	167
Bachelor's-granting inst.	3681	2950	2576	2265	338

** New England—CT, ME, MA, NH, RI, VT; Middle Atlantic—NJ, NY, PA; East North Central—IL, IN, MI, OH, WI; West North Central—IA, KS, MN, MO, NE, ND, SD; South Atlantic—DE, DC, FL, GA, MD, NC, SC, VA, WV; East South Central—AL, KY, MS, TN; West South Central—AR, LA, OK, TX; Mountain—AZ, CO, ID, MT, NV, NM, UT, WY; Pacific—AK, CA, HI, OR, WA.*

***Estimates of potential physics majors are made by the physics department chairpersons.*

Table VII. Trend in entering U.S. and foreign graduate physics students, 1975 to 1992.

Academic year	No. of first-year graduate students			% foreign students of total
	U.S.	Foreign	Total	
1975–76	2095	551	2646	20.8%
1980–81	1720	844	2564	32.9
1985–86	1721	1260	2981	42.3
1986–87	1799	1363	3162	43.1
1987–88	1944	1330	3274	40.6
1988–89	1825	1307	3132	41.7
1989–90	1724	1335	3059	43.6
1990–91	1890	1388	3278	42.3
1991–92	1903	1403	3306	42.4

Graduate enrollment

By extending the enrollment data in **Table VII** back to 1975, we call attention to a 4:1 ratio of U.S. to foreign first-year graduate physics students. In less than ten years (by 1982) the proportion of beginning foreign graduate students doubled (from 20% to 40%). But those rapid changes appear to have quieted down while the efforts of physics faculty to attract more graduate students who are U.S. citizens has yielded some results since 1989.

For a more detailed look at the changing graduate enrollment, we present **Table VIII**, which focuses on the study status and citizenship of all level graduate physics students at two types of institutions. The master's institutions traditionally serve industrial companies in their geographic area by providing limited graduate programs for their employees. Foreign students are primarily interested in doctoral programs, hence the master's institutions tended to attract only a small proportion of them. But, starting in 1980, the number of foreign graduate students who entered the U.S. began to increase so rapidly that they exceeded the number of openings for them in doctoral programs. These students consequently applied for admission to master's institutions with the intention of transferring to a doctoral institution after one or two years. Thus, the impact foreign students have had on the two types of graduate programs is clearly shown by the enrollment trends presented in **Table VIII**.

Table VIII. Full-time, part-time, and foreign graduate physics enrollments by type of institution, 1982 to 1992.

Academic year	Graduate students at doctoral-granting institutions					Graduate students at master's-granting institutions				
	Full-time	Part-time	Foreign	% foreign of total	Total	Full-time	Part-time	Foreign	% foreign of total	Total
1982–83	8 712	812	3193	33.5	9 524	566	339	221	24.4	905
1983–84	9 285	721	3433	34.3	10 006	569	347	254	27.7	916
1984–85	9 647	710	3811	36.8	10 357	604	376	293	29.9	980
1985–86	10 119	818	4259	38.9	10 937	620	454	306	28.5	1074
1986–87	10 538	851	4519	39.7	11 389	772	455	397	32.4	1227
1987–88	11 015	865	4813	40.5	11 880	797	466	448	35.5	1263
1988–89	11 182	887	5049	41.8	12 069	830	462	471	36.5	1292
1989–90	11 643	797	5328	42.8	12 440	839	429	454	35.8	1268
1990–91	11 866	868	5334	41.9	12 700	875	480	489	35.8	1365
1991–92	12 172	946	5460	41.6	13 118	912	497	525	37.3	1409

Table IX. Regional distribution of U.S. and foreign teaching assistants by type of institution, 1991–92.

Geographic region*		Doctoral-granting institutions		Master's-granting institutions	
		Total no. of TA's	Total no. of foreign TA's	Total no. of TA's	Total no. of foreign TA's
New England		551	300	32	19
Mid Atlantic		704	448	26	9
E. N. Central		772	387	170	101
W. N. Central		244	114	59	33
S. Atlantic		612	277	100	29
E. S. Central		168	79	40	19
W. S. Central		413	219	57	31
Mountain		337	153	13	11
Pacific		668	197	71	17
Total	N	4469	2174	568	269
	%		48.6%		47.4%

* *New England—CT, ME, MA, NH, RI, VT; Middle Atlantic—NJ, NY, PA; East North Central—IL, IN, MI, OH, WI; West North Central—IA, KS, MN, MO, NE, ND, SD; South Atlantic—DE, DC, FL, GA, MD, NC, SC, VA, WV; East South Central—AL, KY, MS, TN; West South Central—AR, LA, OK, TX; Mountain—AZ, CO, ID, MT, NV, NM, UT, WY; Pacific—AK, CA, HI, OR, WA.*

Few foreign graduate students receive financial support from their native countries and their visas do not permit them to hold off-campus employment; hence they compete for the available assistantships with U.S. students. **Table IX** shows how many teaching assistantships are available on a geographic basis and what proportion of them are held by foreign graduate students.

Degrees granted

In developing projections of the number of physics doctorates granted in future years, we become increasingly aware of the diversified backgrounds of doctoral candidates. Some foreign students enter doctoral programs with advanced standing while others require extra time to become proficient in English before enrolling in graduate courses. Until the mid 1980s we found a high correlation between the first-year graduate students at PhD-granting institutions and the number of doctorates granted five years later. The current method for projecting the number of doctorates granted takes transfers and different attrition rates into account. Thus **Figure III** projects a further increase to 1300 physics doctorates for the class of 1992, followed by a two-year decline and subsequent increases.

Figure III. Actual and projected number of physics doctorates granted, 1981 to 1996.

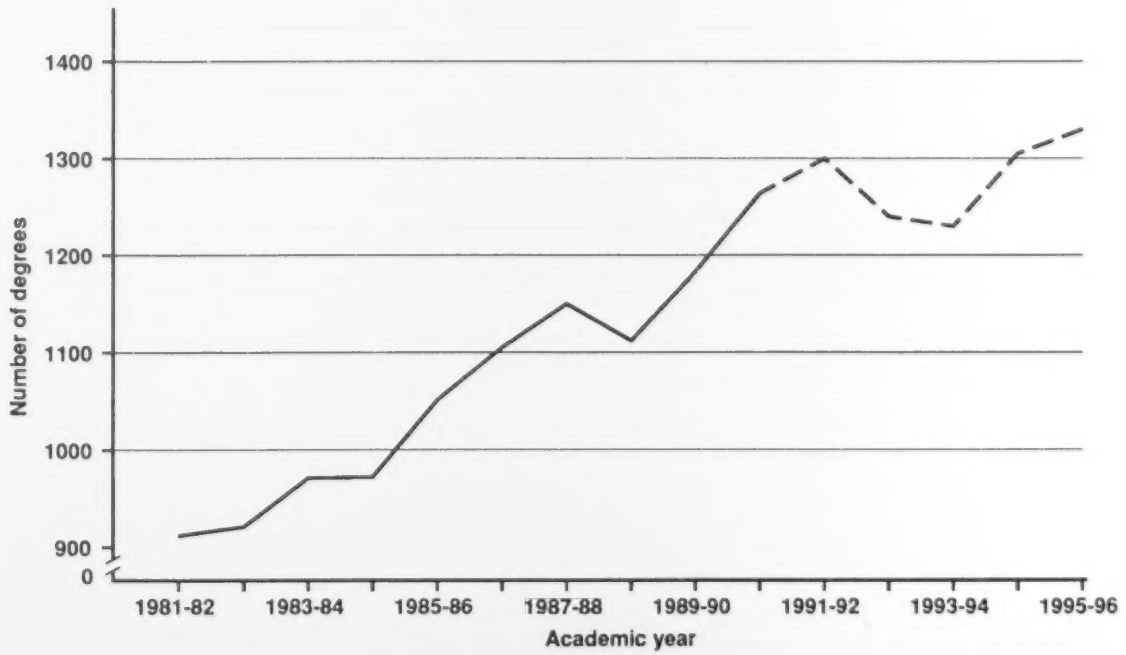


Table X. Physics degrees by type of institution* and geographic region, 1990–91.

Geographic region**	Bachelor's degrees			Master's degree		Terminal master's degrees		Doctorates
	Institution type			Institution type		Institution type		Institution type
	I	II	III	II	III	II	III	III
New England	157	16	329	16	119	1	55	162
Mid Atlantic	420	52	438	16	171	4	112	211
E. N. Central	339	160	272	33	160	55	84	219
W. N. Central	250	33	124	12	26	13	34	71
S. Atlantic	304	79	302	19	105	25	55	132
E. S. Central	129	40	93	12	46	6	17	37
W. S. Central	130	65	205	6	48	20	37	113
Mountain	98	22	251	2	51	6	25	79
Pacific	287	102	448	16	186	42	83	240
Subtotal	2114	569	2462	132	912	172	502	1264
Subtotal				1044		674		
Total		5145			1718			1264

*Institution type indicates the highest physics degree offered; type I = Bachelor's degree, type II = Master's degree, type III = Doctorate.
**See Table IX for explanation of geographic region.

Table X presents a geographic distribution of four types of physics degrees granted by three types of institutions in 1990-91. The format of this table includes some detail on transfer students. For example, the fourth column of data shows that 132 graduates needed to transfer from master's institutions to pursue their doctoral studies. Terminal master's degree are primarily granted by the PhD-granting institutions rather than the master's institutions, and **Table X** indicates a 3:1 ratio for that degree production.

If we define minority groups as those who have a small but notable representation among the physics degree recipients, we need to include the total number of women graduates as well as distinguishing between the U.S. and foreign members of the five ethnic groups listed in **Table XI**. In requesting this detailed information on minority groups from physics departments, we encounter only limited cooperation; hence the totals shown in **Table XI** should be considered lower limits.

Table XI. Number of physics degrees granted by sex and minority group* status and citizenship, 1990–91.

Type of degrees	Sex	Total no. of degrees	Black		Native American Indian	Hispanic		Oriental		Asian Indian		Arab	
			U.S.	Foreign		U.S.	Foreign	U.S.	Foreign	U.S.	Foreign	U.S.	Foreign
Bachelor's	Men	4375	125	13	7	62	13	144	59	50	30	13	11
	Women	770	31	–	2	17	1	35	15	11	6	4	1
	Total	5145	156	13	9	79	14	179	74	61	36	17	12
Master's enroute	Men	892	9	2	1	10	17	23	205	15	41	2	5
	Women	152	2	–	–	1	3	8	50	5	9	–	1
	Total	1044	11	2	1	11	20	31	255	20	50	2	6
Terminal master's	Men	563	5	5	1	6	6	19	86	7	20	4	3
	Women	111	4	–	–	–	1	2	32	3	11	–	–
	Total	674	9	5	1	6	7	21	118	10	31	4	3
Doctor's	Men	1131	5	7	–	9	27	19	293	6	41	2	22
	Women	133	1	1	–	–	2	1	47	–	9	–	1
	Total	1264	6	8	–	9	29	20	340	6	50	2	23

*Minorities in AIP surveys are defined as groups with a low representation in the physics community, but one whose participation has aroused considerable interest.

ASTRONOMY

Table XII. Trend in astronomy enrollments* and degrees, 1982 to 1992.

Academic year	No. of astronomy degrees granted (July 1 to June 30)				Undergraduate astronomy major enrollments		Graduate astronomy enrollments	
	Bachelor's	Master's enroute	Terminal master's	Doctor's	Juniors	Seniors	Total	1st year
1982–83	138	61	22	81	274	232	670	178
1983–84	137	51	22	74	242	217	688	154
1984–85	145	56	16	66	239	212	716	151
1985–86	169	61	24	86	232	252	711	170
1986–87	172	38	23	72	268	255	755	173
1987–88	181	51	24	94	250	285	731	171
1988–89	196	77	16	94	213	275	780	169
1989–90	176	77	17	89	223	200	842	186
1990–91	200	65	25	73	312	218	880	192
1991–92					290	268	901	175

**Include part-time students.*

Compared to physics, the number of astronomy degree-granting departments is small; hence their response to our requests for enrollment and degree data continues to be 100%. A situation described in connection with the physics majors exists also among the astronomy undergraduates where a growing number of them extend their senior status over more than one year. The trend data shown in **Table XII** reflect a substantial decrease in the number of seniors for 1989-90, the year we began to subtract the fifth-year seniors.

Astronomy departments consist of two groups, the separate ones and those that are combined with physics departments. Details of the contributions each type of department made, in terms of the most recent enrollment and degree data, are presented in **Table XIII**. Here we find that the separate doctoral departments play the biggest role in educating astronomers.

This report was prepared with the help of Thomas N. Stovall.

Table XIII. Astronomy enrollments 1991–92 and degrees 1990–91 by type of institution.

	Type of astronomy department		Bachelor's-granting		Master's-granting		Doctoral-granting		Total
			Comb. dep'ts.	Sep. dep'ts.	Comb. dep'ts.	Sep. dep'ts.	Comb. dep'ts.	Sep. dep'ts.	
	Number of dep'ts.*		13	7	2	2	11	30	65
Astronomy degrees	Bachelor's		34	14	7	7	14	124	200
	Master's enroute		–	–	–	–	7	58	65
	Terminal master's		–	–	1	6	2	16	25
	Doctor's		–	–	–	–	7	66	73
Astronomy enrollments	Annual intro. enrollments in astronomy dep'ts.		6 150	2700	1650	1600	6600	40 350	59 050
	Annual enrollments of intro. astronomy taught in physics dep'ts.		40 100		22 750		48 450		111 300
	Total								170 350
	Junior astronomy majors		47	16	6	12	22	187	290
	Senior astronomy majors		33	15	6	7	24	183	268
	Fifth-year undergraduates		9	4	1	2	–	47	63
	First-year graduate students	US	–	–	1	6	13	102	122
		Foreign	–	–	2	–	9	42	53
	Total graduate students	US	–	–	6	18	93	523	640
		Foreign	–	–	3	2	34	222	261

**This survey includes only degree-granting astronomy departments.*